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EXAMINER

NGUYEN, HA T

ART UNIT PAPER NUMBER

2812

DATE MAILED: 06/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/483,881

Applicant(s)

AHN ET AL.

Examiner

Ha T. Nguyen

Art Unit

2812

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 14 April 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 3.5 and 7-142<sup>65</sup> is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 3.5 and 7-142<sup>65</sup> is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Pri rity under 35 U.S.C. §§ 119 and 120**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 16, 17.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## **DETAILED ACTION**

### ***Notice to applicant***

1. Applicant's request for an RCE has been entered and made of record (Paper No. 15). Following is an Office Action responding to this request.

### ***Response to Amendment***

2. In view of new art found and new interpretation of the motivation for the combination of the applied references, the allowability of claims 3, 5, 7-42 and 65 has been withdrawn. The examiner acknowledged that Applicants do not recognized some of the applied art as prior art and will reserve the right to swear behind those reference at a later date.

3. Applicants' arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that there was no motivation to combine the references and asked for evidence showing the well known features stated by the examiner. The examiner disagreed with Applicants' argument. As stated in the rejection in Paper No. 8, Tan et al. (US Patent 6372622, hereinafter "Tan") discloses substantially the limitations of the claims, but Tan discloses forming Cu using electroplating instead of electroless plating. Both Electroplating and electroless plating are conventional methods of depositing metals, at least one of the benefits of using electroless plating compared to electroplating is the simplicity of the method, there is no need to control temperature and supply a current to perform the plating, the energy cost would be lower than the electroplating method which requires a current to be supplied (see Hall, US Patent 4394223, col. 1, lines 16- 40 and Kozlov et al., US Patent 6387542, col. 1, lines 21-48, note that the background portion indicated the state of the art before Kozlov was filed). Bernier et al. also discloses at least one of the benefits of electroless plating: selectivity (see first par. of the "Introduction" ). Even though electroplating has better selectivity than many conventional methods, its selectivity is not as good as electroless plating (see Diamand et al. "Copper electroless deposition technology...metallization" ). The expectation of some advantage is the strongest rationale for combining references (MPEP 2144). Applicants' argument concerning the drawback of Bernier's method of forming the seed layer is irrelevant since it is the electroless

Art Unit: 2812

plating feature of Bernier, which is used not the seed layer. Therefore, it would have been obvious to combine Tan with Bernier.

Therefore, Tan combined with the applied references does teach or make obvious all the limitations of the claims.

Applicants are referred to the new ground of rejection given below.

***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103<sup>©</sup> and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

4a. Claims 3, 5, 7-12 and 65 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan or Earnworth et al. (US Patent 5495667, hereinafter "Earnworth") in view of Bernier et al.'s "Laser processing of palladium for selectively copper plating" (hereinafter "Bernier") or Diamand et al.'s "Copper electroless deposition technology for ultra-large-scale-integration (ULSI) metallization" (hereinafter Diamand).

[Claims 7 and 65] Referring to Figs. 2-6 and related text, Tan discloses a method for forming copper vias on a substrate, comprising: depositing a seed layer including a thin film of Palladium (Pd) or Copper (Cu) on the substrate 10 (see col. 3, lines 39-53); using a photolithography technique in order to define a first number of via holes above the seed layer

Art Unit: 2812

(see Fig. 2); and depositing a layer of copper over the seed layer (see par. bridging cols. 3 and 4)..It also disclose the use of plating to form solder (see col. 4, lines 55-60). But it does not disclose expressly using electroless plating to form the copper layer, the thickness of seed layer; and removing the photoresist layer using oxygen plasma ashing. However, the missing limitation is well known in the art because Bernier or Diamand discloses the use of electroless plating (see Bernier, Abstract or Diamand, Introduction). A person of ordinary skill is motivated to modify Tan with Bernier to use electroless plating to deposit Cu to obtain a simpler and less costly process (see Diamand, Introduction). Besides, any variation in thickness in the present claims is obvious in light of the cited art, because the changes in thickness produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406. The examiner takes Official Notice that it is well known in the art that for electroless plating discontinuous seed layer is used and plasma ashing is a conventional method of removing photoresist.

Earnworth discloses similar features in Figs. 1A-1E, it also discloses the use of - electroless plating (see col. 4, lines 17-42). It fails to disclose a seed layer of Cu or Pd. However it is well known in the art that Cu is used instead of Al to reduce resistivity.

[Claim 3] Tan also discloses wherein depositing a seed layer includes depositing a seed layer using a physical vapor deposition process (see col. 3, lines 40-53). Earnworth fails to disclose this feature, but it is well known in the art.

[Claim 5] Tan also discloses wherein depositing a layer of copper includes filling the number of via holes to a top surface of the photoresist layer (see Fig. 3). Also see EarthWorth Figs. 1A-1E.

[Claims 8 and 14] The arguments used for the rejection of claims 7 and 3 apply.

[Claim 9] The argument used for the rejection of claim 7 applies.

[Claims 10 and 16] Tan discloses wherein depositing a layer of copper over the seed layer includes forming a number of copper vias, wherein the number of copper vias form on the seed layer but not on the patterned photoresist layer (see Fig. 3). Also see EarthWorth Figs. 1A-1E.

Art Unit: 2812

[Claims 11 and 12 ] The arguments used for the rejection of claims 5 and 7 respectively apply.

[Claim 13] The combined teaching of Tan or Earnworth and Bernier or Diamand discloses substantially the limitations of claim 13, as shown above. It also discloses the forming of a second patterned photoresist defining a number of line openings above the copper vias. But it does not disclose expressly the repetition of the steps in the forming of the vias to form conductive lines. However, the transposition of process steps or the splitting of one steps into two, where the processes are substantially identical or equivalent in terms of function, manner and result was held not to patentably distinguish the processes (Ex Parte Rubin, 128 USPQ 440 (Board of Appeals 1959). Earnworth fails to teach forming a number of line opening using photoresist, but this is well known in the art.

[Claim 15] The combined teaching of Tan or Earnworth, Bernier or Diamand discloses substantially the limitations of claim 15. But it does not disclose that the first seed layer is deposited by evaporation. However, the examiner takes Official Notice that this feature is well known in the art.

[Claim 17] The argument used for the rejection of claim 3 applies. Besides, it is within the level of a person of ordinary skill in the art to repeat the similar step to perform similar function.

[Claim 18] The combined teaching of Tan or Earnworth and Bernier or Diamand discloses substantially the limitations of claim 18. But it does not disclose that the thickness of the second patterned photoresist is less than that a thickness of the first patterned photoresist layer. However, it is within the level of skill of a person of ordinary skill in the art to deposit the second patterned photoresist layer to a thickness suitable for the desired purpose, including less than a thickness of the first patterned photoresist layer.

[Claim 19] Tan discloses wherein depositing the second patterned photoresist layer which defines a second number of line openings includes a number of first level line openings (see Fig. 4). Earnworth fails to teach forming a number of line opening using photoresist, but this is well known in the art.

Art Unit: 2812

[Claims 20 and 21] The argument used for the rejection of claim 13 applies. Besides, it is within the level of a person of ordinary skill in the art to repeat the similar step to perform similar function.

[Claims 22 and 23] The argument used for the rejection of claims 13 and 14 concerning the claimed feature apply.

[Claims 24-27] The arguments used for the rejection of claims 10, 7, 3, and 18 respectively apply.

[Claim 34] The arguments used for the rejection of claims 7, 20, and 21 apply. Besides, it would have been obvious for a person of ordinary skill in the art to use the same seed material to form all the needed seed layers to simplify the manufacturing process.

[Claims 35-37] The arguments used for the rejection of claims 22, 3, and 7 respectively apply .

Therefore, it would have been obvious to combine Tan or Earnworth with Bernier or Diamand to obtain the invention as specified in claims 3, 5, 7-27, 34-37, and 65.

5. Claims 13-27 and 34-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan or Earnworth in view of Bernier or Diamand and Simpson (U.S. Patent 6197688)

[Claim 13] The combined teaching of Tan or Earnworth and Bernier or Diamand discloses substantially the limitations of claim 13, as shown above. It also discloses the forming of a second patterned photoresist defining a number of line openings above the copper vias. But it does not disclose expressly the repetition of the steps in the forming of the vias to form conductive lines. However, the missing limitation is well known in the art because Simpson discloses that separately forming conductive vias then repeating the steps to form conductive lines are conventional in the art (See fig. 9 ).

[Claim 14] The argument used for the rejection this feature of claim 8 applies.

[Claim 15] The combined teaching of Tan or Earnworth, Bernier or Diamand, and Simpson discloses substantially the limitations of claim 15. But it does not discloses that the first seed layer is deposited by evaporation. However, the examiner takes Official Notice that this feature is well known in the art.

[Claim 16] The argument used for the rejection of claim 10 applies.

Art Unit: 2812

[Claim 17] The argument used for the rejection of claim 3 applies. Besides, it is within the level of a person of ordinary skill in the art to repeat the similar step to perform similar function.

[Claim 18] The combined teaching of Tan or Earnworth and Bernier or Diamand, and Simpson discloses substantially the limitations of claim 18. But it does not disclose that the thickness of the second patterned photoresist is less than that a thickness of the first patterned photoresist layer. However, it is within the level of skill of a person of ordinary skill in the art to deposit the second patterned photoresist layer to a thickness suitable for the desired purpose, including less than a thickness of the first patterned photoresist layer.

[Claim 19] Tan discloses wherein depositing the second patterned photoresist layer which defines a second number of line openings includes a number of first level line openings (see Fig. 4).

[Claims 20 and 21] The argument used for the rejection of claim 13 applies. Besides, Simpson teaches the repeating of steps to form more than one level of vias and lines (see Fig. 10).

[Claims 22 and 23] The argument used for the rejection of claims 13 and 14 concerning the claimed feature apply.

[Claims 24-27] The arguments used for the rejection of claims 10, 7, 3, and 18 respectively apply.

[Claim 34] The arguments used for the rejection of claims 7, 20, and 21 apply. Besides, it would have been obvious for a person of ordinary skill in the art to use the same seed material to form all the needed seed layers to simplify the manufacturing process.

[Claims 35-37] The arguments used for the rejection of claims 22, 3, and 7 respectively apply.

Therefore, it would have been obvious to combine Tan or Earnworth and Bernier or Diamand with Simpson to obtain the invention as specified in claims 13-27 and 34-37.

6. Claims 28-33 and 38-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan or Earnworth in view of Bernier or Diamand, Simpson and Tomita et al. (U.S. Patent 5034799, hereinafter Tomita).



Art Unit: 2812

[Claim 28] The combined teaching of Tan or Earnworth, Bernier or Diamand, and Simpson discloses substantially the limitations of claim 28, as shown above. But it does not disclose expressly the removal of photoresist layers (sacrificial layers). However, the missing limitations is well known in the art because Tomita discloses this feature (See Figs. 2e and 2f). A person of ordinary skill is motivated to modify Tan or Earnworth, Bernier, Simpson with Tomita to obtain multilevel interconnect structure of low capacitance.

[Claim 29] The argument for the rejection of claim 15 applies.

[Claim 30] ] The combined teaching of Tan or Earnworth, Bernier or Diamand, Simpson, and Tomita discloses substantially the limitations of claim 30, as shown above. But it does not disclose expressly the removal of photoresist layers (sacrificial layers) also remove the first, second, and third seed layers. However, it would have been obvious for a person of ordinary skill in the art to do so since the portions of seed layers not connecting a via and a wiring line are not needed for the operation of the multi-level interconnect.

[Claims 31-33] The arguments used for the rejection of claims 14, 3, and 7 concerning the respectively claimed features apply.

[Claims 38 and 39] The arguments used for the rejection of claims 28 and 30 apply.

[Claims 40-42] Tan discloses the use of a diffusion barrier layer under a copper contact (see col. 3, lines 40-53). When repeating the steps of forming contacts (vias or wiring lines), the barrier layer of the subsequent level (vias or wiring lines) is formed on the previously formed level. But it does not disclose the use of a diffusion barrier on the second level of copper lines and the claimed material. Earnworth fails to disclose these features. However, the examiner takes Official Notice that, these features are well known in the art, they are intended to effectively prevent Cu diffusion to the surrounding environment.

Therefore, it would have been obvious to combine Tan or Earnworth, Bernier, Simpson with Tomita to obtain the invention as specified in claims 28-33 and 38-42.

### ***Conclusion***

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (703)308-2706 . The

Art Unit: 2812

examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling, can be reached on (703) 308-3325. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.



Ha Nguyen

Primary Examiner

6-25 - 03